Characterization of Benthic Marine Fish Communities in Puget Sound

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Puget Sound and adjacent waters are the host to over 200 marine fishes, many of which live on or near the bottom. Since 1987, the Washington Department of Fish and Wildlife (WDFW) has conducted bottom trawl surveys to assess the primary benthic species of marine fishes in the basins that comprise the inland marine waters east of the Sekiu River in both Washington and southern British Columbia (Palsson et al. 2002, 2003, 2004). The abundance patterns of benthic marine fishes in the inland marine waters were evaluated with multivariate techniques in order to identify coherent communities and test for homogeneity of distribution patterns by basin and depth.

WDFW bottom trawl surveys have been conducted at irregular intervals for almost two decades during which over 1,100 trawls have been conducted that have resulted in the capture of 138 marine fish species. Trawl stations have been stratified by basin and by depth zones corresponding to 5-20 fathoms, 21-40 fms, 41-60 fms, and >60 fms in all but the BC Strait of Georgia where a >120 fms stratum was established to encompass the deep Malaspina Trough. Trawl stations were selected systematically until 2001 when trawl stations were selected at random. The net was a 400 mesh Eastern Trawl of 10.2 cm mesh opening in the main body and a codend liner consisting of mesh widths of 3.2 cm. The net opening was determined by previous measurements of net width as a function of depth and deployed trawl cable, and these openings ranged from 8.7-13.7 m. The length of the tow path was determined by radar fixes, LORAN C, or GPS coordinates. The net was towed from 5-15 minutes at a speed of 1.5-2.5 knots. The catch was processed by identifying all fishes, counting their numbers, and weighing each species group. The densities of each species was determined by dividing the abundance in numbers by the area swept by the trawl (the product of the net width and tow length).

Statistical analyses of the numerical densities were facilitated by the community analysis software PRIMER (Plymouth Marine Laboratory, Plymouth United Kingdom) and followed the approach outlined by Clark and Warwick (2001). The data were fourth-root transformed and a Bray-Curtis of matrix of similarity was compiled by trawl station and species. Similarity among species compositions among stations was examined graphically using multi-dimensional scaling (MDS) and subsequently testing for basin and depth differences using a non-parametric analysis of similarity (ANOSIM). Specific species associations were determined using similarity-percentage analysis (SIMPER).

The MDS graphical ordination showed that species composition differed subtly by basins north and south of Port Townsend. The graph suggested a cline from the near oceanic

conditions of the Western Strait of Juan de Fuca to the more inland waters of the Strait of Georgia and southern Puget Sound. ANOSIM analysis, however, revealed that all basins south of Port Townsend and the US Strait of Georgia only differed from the West Juan de Fuca Basin. Re-categorization of the station densities found a significant difference in fish communities between northern and southern basins. Most basin fish communitees were dominated by spotted ratfish (*Hydrolagus collei*), English sole (*Parphrys vetulus*), spiny dogfish (*Squalus acanthias*), walleye pollock (*Theragra chalcogramma*), or Pacific tomcod (*Microgadus proximus*). Differences among the basins were attributed to the dominance of one of these primary species over the other or by the presence of several other common species such as arrowtooth flounder (*Atherestes stomias*), Pacific sanddab (*Citharichthys sordidus*), and Pacific cod (*Gadus macrocephalus*) in the West Juan de Fuca basin, Dover sole (Microstomus pacificus) and Pacific herring (*Clupea pallasii*) in other northern basins, or slender sole *(Lyopsetta exilis*), plainfin midshipman (*Porichthys notatus*), shiner perch (*Cymatogaster aggregata*) and Pacific hake (*Merluccius productus*) in southern basins.

The MDS technique also revealed a cline in species composition from shallow to deep stations, but the ANOSIM revealed that most depth strata were best aggregated into stations shallower and deeper than 40 fms. Several depth specific species patterns were revealed with ubiquitous, shallow, and deepwater species. English sole was ubiquitous, commonly occurred in all but the >120 fm depth stratum. Spotted ratfish was also ubiquitous and occurred commonly at all but the shallowest depth stratum. Spiny dogfish occurred in all depth zones. Shallow species included rock soles (*Lepidopsetta* spp.), speckled sanddab (*Citharichthys stigmaeus*), shiner perch, Pacific sanddabs, and Pacific tomcod. Important deeper species included slender sole, walleye pollock, rex sole (*Glyptocephalus zachirus*), Pacific hake, Dover sole, shortspine thornyhead (*Sebastolobus alascanus*) and longnose skate (*Raja rhina*).

The results of this analysis have an initial benefit in identifying key species that define the diversity and structure of marine fish communities in Puget Sound. Subtle but important differences exist between the West Juan de Fuca and other basins and between northern and southern basins. These differences confirm the basis for differing fisheries management regimes that have historically occurred between theses major geographic areas. The results are also important in evaluating the design of the trawl surveys. Further work will examine if depth zones can be simplified and if a larger geographic scale can be used for the survey frame.

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